REHABILITATION OF FLOOD CONTROL PROJECTS

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GENERAL

The East St. Louis Flood Protection Rehabilitation Project is a $40,000,000 cost shared project that has been executed by the St. Louis District from 1988 to the present time. Most project features are either complete or will be completed in FY98. The project included major rehabilitation of pump stations, gravity drain gatewells, closure structures, relief wells, drainage controls structures, drainage channels/ditches and floodwalls. The East St. Louis Flood Protection Project provides Urban Design flood protection from the Mississippi River and two tributaries to approximately 85,000 acres of highly developed floodplain.

HISTORY

Many features of the East Side Flood Protection Project, including two large pump stations and gravity drains were constructed by local interests from 1900 to 1940. From 1947 to 1970 the Corps of Engineers constructed numerous new project features as well as improvements to existing features. The improvements were to raise the design level of protection to the Urban design level (Stage 52.0 St. Louis). During a period of high water in October 1986 a roller gate on a 10 foot by 12 foot sewer at the East St. Louis Pump Station collapsed causing the evacuation of 1,200 people and $35,000,000 in flood damages. As a result of this failure Congress, in the Energy and Water Development Appropriations Act of 1988, authorized the Corps of Engineers to rehabilitate the entire East St. Louis Flood Protection Project.

PUMP STATIONS AND GRAVITY DRAIN GATEWELLS

This paper will concentrate on the electrical and mechanical rehabilitation of the pump stations and gravity drain gatewells. The vast majority of the rehabilitation work on these facilities took place from 1991 to 1997. Following is a list of each of the major facilities rehabilitated with a description -

NORTH PUMP STATION

Originally built by the East Side Levee District in 1935 and modified by the Corps of Engineers in the early 1960's. The station has four 48-inch vertical pumps each rated at 140,000 gpm and driven by 900 Hp electric motors. In addition there is a 36-inch vertical pump rated at 64,000 gpm that is driven by a 500 Hp vertical electric motor. The pumps discharge through flap gates into a discharge chamber. There a four 8'-4" x 12'-0" steel roller gates located in the discharge chamber for gravity flow shut-off. In addition there are three 12'-0" x 12'-0" steel roller gates located in an emergency gatewell structure located between the pump station and the river. Each discharge chamber roller gate had an electric motor operated gate hoist while each emergency gatewell structure sluice gate had a manually operated gate hoist.

SOUTH PUMP STATION

Originally built by the East Side Levee District in 1926 and modified by the Corps of Engineers in 1960. The station has four 36-inch vertical pumps each rated at 59,000 gpm and driven by 400 Hp electric motors. The pumps discharge over the levee The pump station forebay has ten 5'-0" x 5'-0" cast iron sluice gates. There is an adjoining triple box culvert gravity drain with three 10'-0" x 12'-0" cast iron sluice gates. Each station forebay sluice gate had an electric motor operated gate hoist while each gravity drain sluice gate had a manually operated gate hoist.

MADISON PUMP STATION

Built by the Corps of Engineers in 1963. The station has three 36-inch vertical pumps each rated at 54,000 gpm and driven by 400 Hp electric motors. The pumps discharge through cast iron flap gates into a discharge chamber. There a two 6'-0" x 7'-0" cast iron sluice gates located in the discharge chamber for gravity flow shut-off. In addition there are two 6'-0" x 7'-0" cast iron sluice gates located in an emergency gatewell structure located between the pump station and the river. The pump station has three 6'-6" x 6'-6" cast iron sluice gates located between the

station forebay and the sump. Each sluice gate had a manually operated gate hoist.

CANAL NO. 1 PUMP STATION

Built by the by the Corps of Engineers in 1960. The station has three 18-inch vertical pumps each rated at 19,000 gpm and driven by 125 Hp electric motors. The pumps discharge over the levee There is an adjoining gravity drain with two 7'-0" x 7'-0" cast iron sluice gates. Each sluice gate had a manually operated gate hoist.

VENICE PUMP STATION

Built by the Corps of Engineers in 1957. The station has three 24-inch vertical pumps each rated at 13,500 gpm and driven by 200 Hp electric motors. The pumps discharge over the levee into a junction chamber. There is an adjoining gravity drain with one 4'-0" x 4'-0" cast iron sluice gate. The pump station has two 4'-0" x 4'-0" cast iron sluice gates located between the station forebay and the sump. Each sluice gate had a manually operated gate hoist.

CAHOKIA PUMP STATION

Built by the Corps of Engineers in 1949. The station has one 24-inch vertical pump rated at 27,000 gpm and driven by a 25 Hp electric motor and an 18-inch vertical pump rated at 14,000 gpm and driven by a 100 Hp electric motor. The pumps discharge over the levee into the gravity drain gatewell structure. There is an adjoining box culvert gravity drain with a 6'-0" x 8'-0" cast iron sluice gate. The sluice gate had a manually operated gate hoist.

EAST ST. LOUIS PUMP STATION

Built by the Corps of Engineers in 1960. The station has three 60-inch vertical pumps each rated at 147,000 gpm and driven by 1500 Hp electric motors. The pumps discharge through cast iron shutter gates into a discharge chamber. There is a 12'-6" x 12'-6" steel roller gate located in the discharge chamber for gravity flow shut-off. In addition there is a 12'-6" x 12'-6" steel roller gate located in an emergency gatewell structure located between the pump station and the river. The pump station has three 14'-0" x 10'-0" steel roller gates located between the station forebay and the sump. There is also an adjoining gravity drain with a 10'-6" x 10'-6" cast iron sluice gate. The pump station forebay and the emergency gatewell roller gates had manually operated gate hoists. The adjacent gravity drain sluice

gate and the station gravity drain roller gate each had an electric motor operated gate hoists. Since this was the pump station where the gravity drain roller gate failed in 1986 the Metro East Sanitary District installed a new gravity drain roller gate and switchgear prior to the Corps' rehabilitation project. In addition, after studies and tests, the Corps determined that rehabilitation of the stormwater pumps at this pump station was not required.

GRANITE CITY NO. 1 AND No. 3 SEEPAGE PUMP STATIONS

Built by the Corps of Engineers in 1957. Each station has two 8-inch vertical pumps each rated at 2,500 gpm and driven by 25 Hp electric motor. Each station has no structure surrounding the equipment other than a chain link fence and a tin roof.

GRANITE CITY NO. 2 SEEPAGE PUMP STATION

Built by the Corps of Engineers in 1957. Each station has two 8-inch vertical pumps each rated at 3,600 gpm and driven by 40 Hp electric motor. The station has no structure surrounding the equipment other than a chain link fence and a tin roof.

PHILLIPS REACH SEEPAGE PUMP STATION

Built by the Corps of Engineers in 1962. Each station has two 16-inch vertical pumps each rated at 1,950 gpm and driven by 50 Hp electric motor. The station has no structure surrounding the equipment other than a chain link fence and a tin roof.

MOPAC GRAVITY DRAIN

Built by the Corps in 1957 this facility has two box culverts with a gatewell structure with two 8'-0" x 8'-0" sluice gates.

OTHER PUMP STATIONS

There are two additional pump stations, Monsanto and IR-8, which are part of the flood protection project which were not rehabilitated. This was due to the fact that these stations no longer are operated due to the presence of hazardous waste in the gravity drain portions of these stations.

SCOPE OF THE REHABILITATION WORK

The following scope of work was developed for the rehabilitation of each facility.

REHABILITATION OF EACH STORMWATER PUMP

Each pump would be removed, disassembled, all components either replaced or cleaned and inspected (list follows), painted, reinstalled and tested. In addition each pump station sump had all debris and silt removed.

Replace all shaft sleeves and bearings.

Inspect each shaft and shaft coupling.

Inspect the propeller.

Balance the propeller.

Inspect the cast bowl sections with repair of areas of cavitation damage with metal putty.

Remove the existing manual Farval lubricators and installation new electric motor driven, automatic lubricators.

Install new lubrication lines to each bearing.

Replace all packing.

Replace all fasteners using corrosion resistant materials.

REHABILITATION OF EACH PUMP DRIVE ELECTRIC MOTOR

Each motor would be removed, disassembled, each component cleaned and inspected, painted, reinstalled and tested. In addition, the following specific actions were taken on each motor.

New windings and insulation.

Balance the rotor.

Install winding heaters.

REHABILITATION OF EACH SLUICE GATE

Each sluice gate would be removed including the slide, frame and guides. each component cleaned and inspected, painted, reinstalled and tested. In addition each gravity drain was cleaned of all debris and silt. In addition, the following specific actions were taken on each sluice gate.

Replace each manually or electric motor operated gate hoist with a new electric motor operated gate hoist. The only exceptions to

this were for the emergency gatewell structure sluice gates where new manually operated gate hoists would be installed.

Replace each stem and all stem guides.

Replace all fasteners using corrosion resistant materials.

REHABILITATION OR REPLACEMENT OF EACH ROLLER GATE

Each roller gate scheduled for rehabilitation would be removed including the slide, guides and rails, each component cleaned and inspected, painted, reinstalled and tested. In addition, the following specific actions were taken on each roller gate.

Replace each manually or electric motor operated gate hoist with a new electric motor operated gate hoist. The only exceptions to this were for the emergency gatewell structure roller gates where new manually operated gate hoists would be installed.

Replace each stem and all stem guides.

Replace each rubber J-bulb seal.

Replace all guides, rails and rollers (including bushings).

REPAIR OR REPLACEMENT OF EXISTING ELECTRICAL EQUIPMENT

Replace all switchgear including pump motor starters, main breakers, power distribution panels and pump motor protective devices.

Replace all lighting panels

Replace all indoor and outdoor light fixtures.

Replace all conductors.

Replace each conduit that had been shown to be deteriorated.

Install disconnects at each piece of motor operated equipment.

REPAIR OR REPLACEMENT OF AUXILIARY EQUIPMENT AND FEATURES

Replace restroom facilities where there were existing ones. This included installing sanitary holding tanks since previous waste was sent directly into the sump.

Replace overhead ceiling, wall and sump ventilation equipment including fans, louvers, dampers, vents, unit heaters, room air

conditioners and ductwork that no longer functioned properly.

REPAIR OR REPLACEMENT OF ARCHITECTURAL AND STRUCTURAL ITEMS

Replace each roof including new downspouts and guttering.

Replace each door

install new fiberglass ladders and guardrail.

Tuckpointing where needed.

Concrete patching and repair where needed.

CARE OF WATER

Each facility required care of water plans to be designed and installed by the contractors. There were multiple purposes for each of these plans.

To minimize the number of pumps not in service the contractors were required to remove only a certain number of pumps each time and have the rehabilitated pumps tested and back in service prior to removal of additional pumps. Removal of pumps was also tied to Mississippi River stages and forecasts.

To minimize the number of gravity drain sluice gates or roller gates not in service the contractors were required to remove only one sluice gate or roller gate at a time and have the gate reinstalled, tested and back in service prior to removing additional gates. The contractors were required to design, fabricate and install slots and stoplogs to replace the various sluice gates and roller gates while rehabilitation work on those gates was ongoing. Cofferdams were required at some facilities in order to allow work to be done in the dry. Removal of sluice and roller gates was also tied to Mississippi River stages and forecasts. The contractors were also required to clean out various gravity drain pipes or box culverts that were blocked with silt and debris. This was done to allow diversion of flow around the work areas of the gates being rehabilitated or replaced.

CONTRACTUAL PACKAGING OF THE VARIOUS ITEMS OF WORK

The work which has been described was covered in two different Local Cost Sharing Agreements (LCA's). Due to this fact the work was not split up by facility but was packaged as follows.

LARGE GRAVITY DRAINS

This included the gravity drain sluice gates or roller gates that were contained in structures separate from the pump station structures. This included the emergency closure gatewell structures at the Madison and North Pump Stations.

EAST ST. LOUIS AND MADISON PUMP STATIONS

SOUTH AND CANAL NO. 1 PUMP STATIONS

NORTH AND VENICE PUMP STATIONS

CAHOKIA PUMP STATION

GRANITE CITY NOS. 1, 2, 3 AND PHILLIPS REACH PUMP STATIONS

STRUCTURAL/ARCHITECTURAL REHABILITATION OF PUMP STATIONS
This contract included all the structural and architectural work described and some of the miscellaneous mechanical and electrical work including restroom facilities and light fixtures.

CONTRACT HISTORIES

Following is a list of each of the major contract packages to illustrates how the rehabilitation contracts increased in price due to additional repair work required and problems discovered during the rehabilitation project.

Contract	Govt. Estimate	Contract Award	Final Amount
Large Gravity Drains (8A Contract)	$1,159,000	$1,159,000	$1,623,614
East St. Louis and Madison Pump Stations	$1,503,440	$833,700	$1,056,502
South and Canal No. 1 Pump Stations	$2,225,500	$1,556,000	$2,002,355
Cahokia Pump Station	$471,535	$362,309	$480,885
Granite City Nos. 1, 2, and 3 and Phillips Reach Pump Stations	$493,820	$376,700	$479,959
Structural/Architectural Rehab of the Pump			

Stations	$1,369,060	$936,600	$976,938*
North & Venice Pump Stations (8A Contract)	$2,755,142	$2,755,142	$3,818,762**

* - some work items deleted
** - not completed at present time

REASONS FOR COST GROWTH

There are many reasons for the increases in the final contract amounts. Many of these can be expected during rehabilitation work on older facilities. There were others, however, that were unexpected. Following is a list of the major items which contributed to this cost growth.

ADDITIONAL DAMAGE TO EQUIPMENT

Pumps

Pump shafts were worn badly and had to be replaced.

Impeller tips were worn badly. This required brazing and machining of each blade edge to original dimensions.

Most shaft couplings had to be cut to separate shaft sections. This resulted in these coupling being replaced.

Most flange fits had to be repaired by welding material to the flange and remachining to correct dimensions and tolerances.

The amount of cavitation damage in the impeller bowl was much greater than expected. Either more epoxy repair than specified was required or a bronze bowl liner was fabricated and installed in the bowl section.

Most enclosing tubes had to be replaced due to damaged threads.

Pump Drive Motors

The main change was that all thrust and guide bearings were replaced due to wear, flat spots on the rollers and corrosion.

Sluice Gates

Bronze seal surfaces were rough and had to be cleaned.

Many wedge assemblies were replaced due to wear and corrosion.

Two gate slides were cracked (MoPac Gravity Drain) and one gate was severely corroded (East St. Louis Pump Station) which resulted in replacement of these gates.

Roller Gates

Each roller gate scheduled for rehabilitation was replaced due to severe corrosion to the beams, girders, stiffeners and gates

guides. In many cases entire sections of the beams and girders were missing.

DELAYS AND ADDITIONAL COSTS DUE TO HIGH RIVER LEVELS AND FLOODS

The flood of record for St. Louis occurred in the summer of 1993 with the Mississippi River almost 20 feet over flood stage. In addition the duration of this flood surpassed any previous one. The third highest flood of record occurred in the spring of 1995 with the Mississippi River nearly 12 feet over flood stage. This prevented work on the various pump stations and gravity drains which were being rehabilitated at that time. For instance, in 1993, little or no work occurred from March until November due to the high river levels.

During periods of high water or predicted periods of high water the contractors were not allowed to remove pumps, sluice gates or roller gates since this could have an effect on the operability of the flood control project. In addition when river levels permitted work the contractors were only allowed to remove one, and is a few cases two, pumps, sluice gates or roller gates in order to minimize a flooding risk while the rehabilitation work took place.

In most instances the cofferdams constructed to protect the work areas were overtopped and washed away. This also occurred due to severe interior storms. In June 1994 an extremely heavy and intense storm over the southern portion of East St. Louis caused flows in the ditches leading to the South Pump Station to reach near record levels. Not only were the cofferdams washed away but due to the fact that the forebay sluice gates had been removed for rehabilitation the velocity of the flows caused a portion of the soil foundation under the pump station to be washed away. Each time these events occurred the contractors were paid to rebuild and/or reinstall their care of water plans. In addition many of these events caused a build up of silt which had just been removed and required payment to the contractor to remove an additional time. At many of the pump stations and gravity drains the problem was that in order to install the care of water plans the Mississippi River levels had to be extremely low for a period of 1-2 weeks. While historically these levels were reached more than once each year on average the number of these occurrences in the past five years has been unusually low.

RED LEAD PRIMER

Red lead primer was discovered when the pumps and sluice gates were sandblasted prior to the inspection of these items. This resulted in expensive measures being required to contain and

dispose of properly the paint and primer chips.

CONTAMINATION

Materials classified as "Special Waste" were discovered in the sumps and gravity drains if some of the facilities located at the end of combined sewers. This resulted in all work in the area suspended until the material could be removed and disposed of properly. This was costly both in terms of work completion delays and the actual removal/disposal of the material.

LESSONS LEARNED

Following are the lessons learned by the St. Louis District during the execution of this project.

CARE OF WATER PLANS

Be more specific in the way the care of water plans are designed and installed by the Contractors. Specify exact levels of protection to be provided. Specify not only what river stages that work cannot occur but also specify at what river stages the contractor is required to work.

PUMPS

For any pumps 30+ years old replace the pump shaft, all shaft couplings and repair all flange fits to correct dimensions and tolerances.

Consider removable impeller bowl liners wherever there is a significant amount of cavitation damage to repair.

ELECTRIC MOTORS

For any motors 30+ years old replace all thrust and guide bearings.

ROLLER GATES
For any roller gates 25+ years old assume complete replacement.

RED LEAD PRIMER

Test all items to be sandblasted to determine if red lead primer is present prior to the preparation of the contract plans and specifications.

CONTAMINATION

Test all silts located in pump station sumps and gravity drains prior to preparation of the contract plans and specifications.

CONTRACT PACKAGING

Do not break up the work at any one pump station into multiple contracts. This prevents coordination problems between contractors and insures that all the necessary work is completed and not lost between the contracts.